(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 875 322 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.11.1998 Bulletin 1998/45

(51) Int Cl.⁶: B23B 51/00, B23B 27/16

(21) Application number: 98850043.5

(22) Date of filing: 25.03.1998

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 30.04.1997 SE 9701664

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(54) Drill

(57) The present invention relates to a drill for drilling of metallic workpiece, as well as a cutting insert for use in this drill. The drill consists of a drill shank with at least two straight or helical chip flutes and at least two insert pockets for a substantially square central insert (16) and a peripheral insert (17). The operative edge (26B) of the peripheral insert (17) protrudes sideways such that the diameter of the drill hole is determined thereby during chip transport through one chip flute and the operative edge (26A) of the central insert (16) is provided radially inside the periphery of the drill shank (11) for chip transport through the other chip flute. The operative edges (26A,26B) of the cutting inserts (16,17)) overlap each other at an area (Z) between the rotational axis (CL) and the periphery. The operative edge (26A) of the central insert (16) extends in to and preferably a piece past the drill axis of rotation (CL). The central insert has four cutting edges (26) with rake surfaces which define at least one rake angle. The rake angle for the operative edge (26A) of the substantially square central insert (16) is larger at the area (Z) for overlap than at the rotational axis (CL) of the drill.

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Description

Background

The present invention relates to a drill for drilling of metallic workpieces, as well as a cutting insert to be used in connection with the drill according to the preambles of the appended independent claims.

Prior art

In a known drill of the above-mentioned type the drill has square indexable inserts. The drill has a central insert and a peripheral insert of identical design. The central insert overlaps the axis of rotation of the drill and the peripheral insert overlaps the central insert. Each corner portion of the central insert comprises a chamfer which in operative position is arranged to overlap the rotational axis. At indexing of the central insert it has showed that said previously centrally located chamfer gets into operative position also after indexing, such that the cutting insert does not cut as light as a new cutting insert. This means that the cutting insert actually only can give two not worn cutting edges per cutting insert, which is uneconomical.

Objects of the present invention

One object of the present invention is to provide a drill, the cutting insert of which has four cutting edges, where worn portions do not endanger indexing into operative position.

Another object of the present invention is to provide a light cutting insert with four cutting edges.

Short description of the drawings

The invention is more closely described below in connection with subsequent drawings, wherein:

Fig. 1 shows a side view of a working end of a drill according to the present invention; Fig. 2 shows a top view of the working end surface; Fig. 3 shows a plan view of a cutting insert according to the present invention; Fig. 4 shows a cross section according to the line IV-IV in Fig. 3; Figs. 5 and 6 show cross-sections according to the lines V-V and VI-VI, respectively in Fig. 3; Fig. 7 shows a plan view of an alternative cutting insert according to the present invention; Fig. 8 shows a cross-section according to the line VIII-VIII in Fig. 7; Figs. 9 and 10 show cross-sections according to the lines IX-IX and X-X, respectively in Fig. 7, and Fig. 11 schematically shows the overlap of the central and peripheral inserts.

Detailed description of the invention

Figs. 1 and 2 show a cylindrical drill shank 11 that is provided with two insert pockets at its forward part placed at each side of the center line CL of the drill. Helical recesses or chip flutes for the chip transport are designated with 14 and 15. Both insert pockets are provided with central holes for receiving locking screws (not shown) for clamping of cutting inserts in the pockets in a known manner. The pockets consist of a central pocket which is provided radially inside the periphery of the drill shank 11, and a peripheral pocket which terminates in the periphery of the drill shank. The insert pockets are designed in the drill shank 11 in a manner such that they disclose different axial clearance angles and together with the cutting inserts achieve full drilling of the entire hole diameter.

Each cutting insert pocket comprises a tangential support surface, an axial support surface as well as a radial support surface. The support surfaces are designed for cutting inserts with positive cutting geometry. The tangential support surfaces is substantially parallel with a radial plane through the center line CL.

The central pocket is provided to receive a central insert 16, the operative edge 26A of which protrudes in the axial direction relative to the associated pocket in order to cut centrally located material.

The peripheral pocket is provided to receive a square peripheral insert 17, the operative edge 26B of which protrudes relative to the drill shank in the radial direction such that the hole diameter of the drill is determined thereby. The peripheral pocket and the peripheral insert 16 are inclined relative to the center line CL of the drill shank 11 an acute angle of about 2 to 3° for obtaining of requisite clearance for the peripheral insert.

Furthermore, the drill shank 11 is provided with a number of channels 34, 35, which transfer flushing medium to the cutting area for removal of cut chips via the chip flutes 14, 15.

Figs. 3 to 6 show an indexable insert 16 for use in the above-described central pocket of the drill shank. The cutting insert 16 has a substantially square basic shape including an upper planar surface 22 and a lower planar surface 23, which are substantially parallel to each other. The planar surfaces 22,23 connected by side surfaces 24, which are substantially equally long. The lower planar surface 23 is smaller than the upper planar surface 22, and therefor the cutting insert obtains a positive clearance angle. The lines of intersection of the side surfaces 24 with the upper planar surface 22 form four major edges 26, whereof only one edge 26A is operative and machines the work piece at each drilling operation.

A bisector B at each corner portion 27 of the central insert is defined by a diagonal line between the points of intersection for imaginary lines of extension for the main cutting edges 26. The major cutting edge 26 comprises a first chamfer edge 28, a second chamfer edge 29 and an intermediate cutting edge 126. In the vicinity of one end of the major cutting edge 26 the first chamfer edge 28 connects to the intermediate cutting edge 126 which in its turn connects to the second chamfer edge 29 in the vicinity of the other end of the major cutting

edge 26. The first chamfer edge 28 forms a first acute angle β1 with the longitudinal extension of the preferably straight, intermediate edge 126 of the insert and the second chamfer edge 29 forms a second acute angle β2 with the longitudinal extension of the edge 126. The first acute angle β is about 25° and the second acute angle β2 is about 25°. The chamfer edges 28 and 29 from different major cutting edges 26 intersect in or in the vicinity of the bisector B. The inner angle between the edge surface 24 and a reinforcing chamfer 30, connected to the major cutting edge 26, is called an edge angle and is less for the areas of the cutting edge 126 and the second chamfer edge 28 than for the second chamfer edge 29, which best appears from Figs. 5 and 6. The reason for differing edge angles on the chamfer edges 28 and 29 is that the first chamfer edge 28 during drilling will have no or slow cutting speed since this is provided overlapping the rotational axis in the center of the drill. Thereby, the strength of the chamfer edge 28 becomes better if the cutting edge angle is relatively large, i.e. it is blunt and lies within the interval of 91-110°, preferably in the magnitude of 94°. Stated in another way, the chamfer edge and reinforcing chamfer form a negative angle y with a plane which intersect the cutting edges 126, said angle being about 15°. The second chamfer edge 29 like the cutting edge 126 shall work at higher cutting velocity than the first chamfer edge and need not be strengthened by chamfers, and therefor the cutting edge angle is chosen acute there, i.e. it is less than 90° but bigger than 75°. The operative cutting edge 26A preferably consists of a straight intermediate cutting edge 126, but the cutting edge 126 may alternatively be somewhat convexly or concavely discontinuous.

A first rake surface 31 connects to the radially inner edge of the strengthening chamfer 30 of the intermediate cutting edge 126 and the second chamfer edge 29, which rake surface is formed for chip breaking and has the shape of a groove 32. The groove 32 can be combined with from each other separate projections or recesses. The groove 32 has marked lines of intersection.

The rake surface 31 forms a rake angle α1 with a plane which runs through the strengthening chamfers 30 or with a line perpendicular to the surface of the workpiece, not shown. The rake angle α1 lies within the interval of 5 to 20°. The groove 32 further connects to the upper planar surface 22.

A second rake surface 33 connects to the first chamfer edge 28, which rake surface has the shape of a substantially planar surface. The rake surface 33 forms a rake angle a2, which is about 0°, for reinforcing the corner portion. The rake surface 33 further connects to the upper planar surface 22 via a concave ridge 36.

This consequently implies that the rake angle is neutral where the cutting edge needs strength and positive where the cutting edge needs to cut easily. This is obtained by raising the second rake surface 33 at the corner portion 27 in relation to the first rake surface 31 along the cutting edges 126 and 29.

In other words the rake angle α1, α2 for the operative edge 26A of the substantially square central insert 16 larger at one side of the bisector B than at the other side of the bisector. It should however be observed that two next to each other lying chamfer edges 28, 29 are not intended to cut material simultaneously, but that the chamfer edge 28 during drilling cooperates with the connected intermediate cutting edge 126 as well as a second chamfer edge 29 at an adjacent corner portion 27.

The length of the cutting insert 16, which is defined by the distance between two parallel intermediate edges 126, is depicted with L, which for the cutting insert in Fig. 3 is about 8 mm.

In Figs. 7-10 is shown an alternative cutting insert 16' according to the present invention where the same details are numbered as above. The cutting insert 16' is adapted for smaller dimensions, where the distance L is about 6 mm and thinner. What differs the cutting insert 16' from above described cutting insert is partly that the rake surface 33' connects in the same plane to the upper the planar surface 22 and that the groove 32' lacks marked lines of intersection. Furthermore, the first acute angle β1 is here about 30° and the second acute angle β2 is about 30°.

With reference to Figs. 1, 2 and 11 the function of the drill shall be described. The cutting inserts 16 and 17 are provided at each side of the center line CL of the drill with about 180°:s partition and their operative major edges 26A and 26B, respectively cooperate in order to cut chips from a work piece forming a hole 40 which is somewhat larger than the diameter of the drill shank 11 while side surfaces 24 of their non-operative major edges support against the axial and radial support surfaces of the pockets. In Fig. 11 is schematically shown how the cutting inserts divide the cutting work at one side of the rotational axis CL. The central insert 16 or 16' is positioned in the central pocket less than a millimeter axially short of the peripheral insert 17 in the feed direction F. The cutting edge 126 forms an acute angle with the rotational axis CL. This gives the drill a geometry which fits for a so called stack drilling operation. The cutting insert 16 may alternatively be angled such that it forms an obtuse angle with the rotational axis. The first strong chamfer edge 28A of the central insert is provided in and in the vicinity of the rotational axis, where the cutting speed is low at drilling. The peripheral insert 17 is provided such that its operative edge 26B during drilling will overlap the second chamfer edge 29 of the central insert at the area, the point or the line Z at a distance O from the rotational axis. The central insert and the peripheral insert are provided in the drill body such that the bisector B always will lie radially outside the rotational axis CL and the point Z for overlap. This implies that the heavily cutting first chamfer edge 28b on the other side of the bisector up to left in the figure will be "shadowed" of the edge 26B of the peripheral insert, i.e. the first chamfer edge, which is distant from the rotational axis, never comes into engagement with the work piece since the

cutting edge 26B takes care of that cutting work. During drilling that results in that the drill can work with relatively small energy consumption and that the more peripheral part of the rake surface 31 can be provided with chip formers which do not need to be adapted for low cutting speed. The rake surface 31 forms well shaped chips which can be flushed away via the preferably helically shaped chip flute 14. The peripheral insert 17 will machine with relative high cutting speed and should thereby have a positive rake angle for diminishing the heat development and thereby attain a good life-span for the cutting insert. The second chamfer edge 29C next to the chamfer edge 28A will be hidden in the "shadow" of the cutting edge 28A due to the cutting edge 29c being provided axially rearwardly of the cutting edge 28A as well as on opposite side of the rotational axis. The rotational axis intersect the chamfer edge 28A in or in the vicinity of the bisector B.

From a cutting insert with the shown shape is attained four cutting edges, wherein each new triple of cutting edges 28A, 126 and 29A will be unaffected of previous drilling with adjacent cutting edges.

The cutting insert 16, 16' is made in hard material, preferably in cemented carbide such as sintered tungsten carbide.

The present invention consequently relates to a drill and a cutting insert therefore, wherein the cutting insert is developed such that it makes the drill light cutting and economical. The cutting insert is further developed for giving four cutting edges.

Although the present invention has been described in connection with preferred embodiments thereof, it will be appreciated by those skilled in the art that additions, deletions, modifications, and substitutions not specifically described may be made without departing from the spirit of the invention as defined in the appended claims.

Claims

1. Drill comprising a drill shank (11) having at least two straight or helical chip flutes (14,15) and at least two insert pockets for a substantially square central insert (16;16') and a peripheral insert (17) whereof the operative edge (26B) of the peripheral insert (17) protrudes sideways such that the hole diameter of the drill is determined thereby during chip transport through one chip flute (15) and the operative edge (26A) of the central insert (16;16') is provided radially inside the periphery of the drill shank (11) for chip transport through the second chip flute (14), said operative edges (26A,26B) of the cutting inserts (16,17;16',17) overlapping each other in an area (Z) between the rotational axis (CL) and the periphery, said operative edge (26A) of the central insert (16;16') extending in to and preferably a piece past the drill axis of rotation (CL), said cutting insert having four cutting edges (26) with rake surfaces (31) which define at least one rake angle ($\alpha 1$, $\alpha 2$), **characterized by** that the rake angle for the operative edge (26A) of the substantially square central insert (16;16') is larger at the area (Z) for overlap than at the rotational axis (CL) of the drill (10).

2. Drill according to claim 1, **characterized by** that the operative edge (26B) of the peripheral insert (17) is provided to withhold a part (28B) of a radially and axially external corner portion of the central insert (16;16') from engaging a work piece, said part (28B) having a smaller rake angle ($\alpha 2$) than the rake angle ($\alpha 1$) of the operative edge (26A) of the central insert (16) at the area (Z).

3. Drill according to claim 1, **characterized by** that the geometries of the central insert (16;16') and the peripheral insert (17) are different and that the central insert and the peripheral insert are provided in the drill body such that the bisectors (B) for two operative corner parts (27;27') always lie radially outside the rotational axis (CL) and the area (Z) for overlap.

4. Central insert for a drill of the type indicated in claim 1, comprising an upper and a lower planar surface (22,23) with substantially square basic shape as well as them connecting side surfaces (24), said lower planar surface (23) being smaller than the upper planar surface (22) such that the cutting insert (16) obtains a positive cutting geometry, wherein cutting edges (26) are formed at upper edges of the side surfaces (24), said central insert comprising four corner parts (27), each defined by a bisector (B), said cutting insert having a rake surface which defines at least one rake angle ($\alpha 1$, $\alpha 2$), **characterized by** that each cutting corner is asymmetrically provided around the associated bisector (B) and that the rake angle ($\alpha 1$) for the operative edge (26A) of the substantially square central insert (16) is larger at one side of the bisector (B) than at another side of the bisector (B).

5. Cutting insert according to claim 4, **characterized by** that a part (28b) of a the radially and axially external corner portion (27;27') of the central insert (16;16') is provided to be withheld from engaging a work piece, said part having a smaller rake angle ($\alpha 2$) than the rake angle ($\alpha 1$) for the operative edge (26A) of the central insert (16; 16').

6. Cutting insert according to claim 5, **characterized by** that the operative edge (26A) of the central insert (16;16') comprises a first chamfer edge (28A), a second chamfer edge (29A) and an intermediate cutting edge (126), said first chamfer edge (28) in the vicinity of one end of the major cut-

ting edge (26A) connecting to the intermediate cutting edge (126) which in its turn connects to the second chamfer edge (29A) in the vicinity of the other end of the major cutting edge (26A).

7. Cutting insert according to claim 6, **characterized by** that the first chamfer edge (28A) forms a first acute angle (β1) with the longitudinal extension of the preferably straight intermediate edge of the insert (126) and that the second chamfer edge (29A) forms a second acute angle (β2) with the longitudinal extension of the edge (126).

8. Cutting insert according to claim 7, **characterized by** that a first rake surface (31) connects to a radially inner edge of a strengthening chamfer (30) of the intermediate cutting edge (126) and the second chamfer edge (29), said rake surface being formed for chip breaking and has the shape of a groove (32).

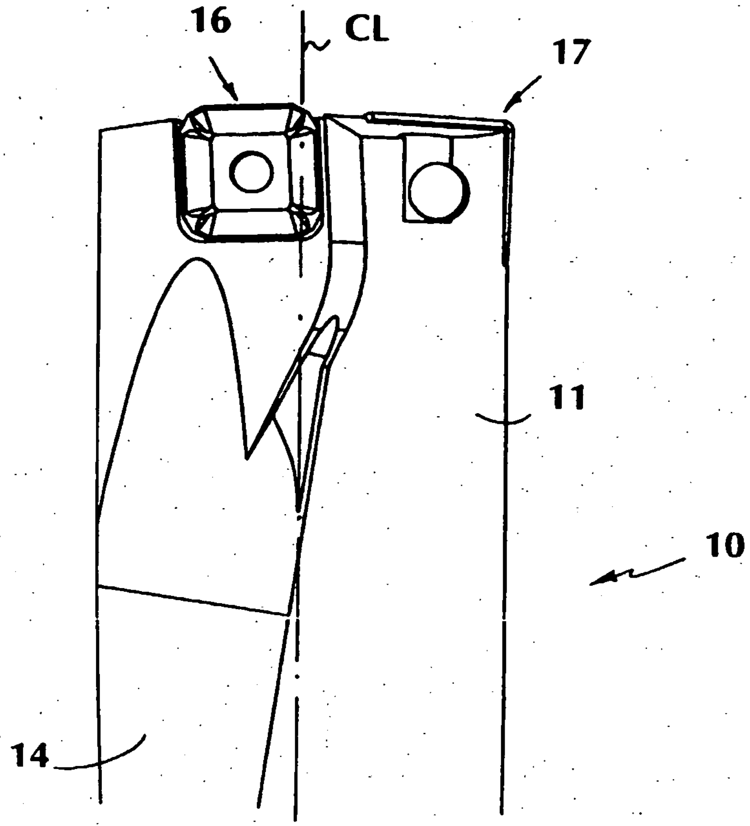

Fig. 1

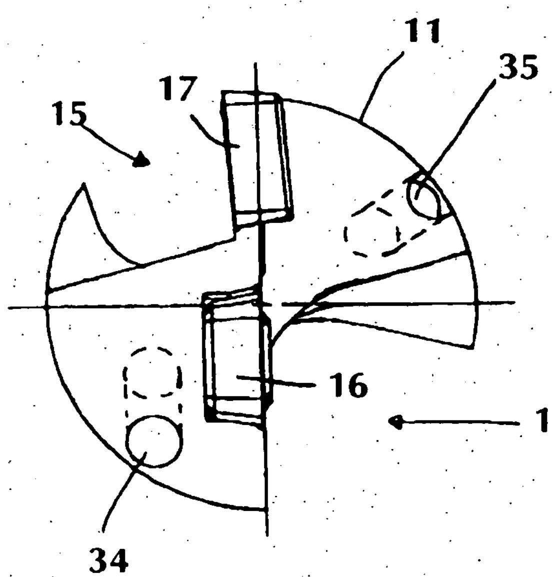

Fig. 2

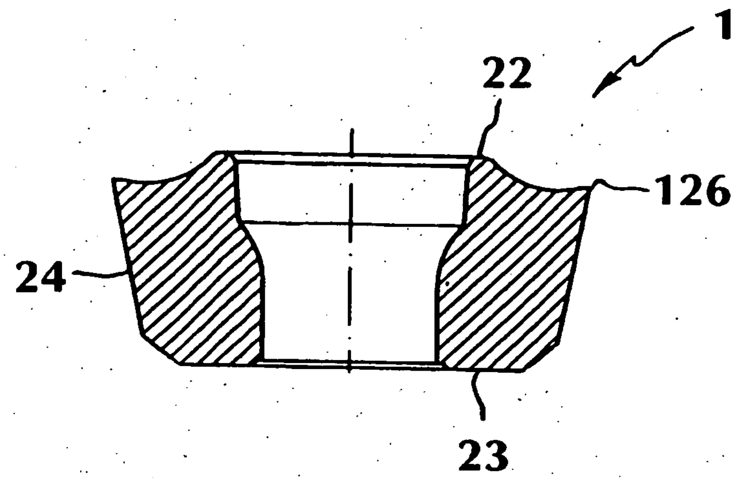
16
22
126
24
23

Fig. 4

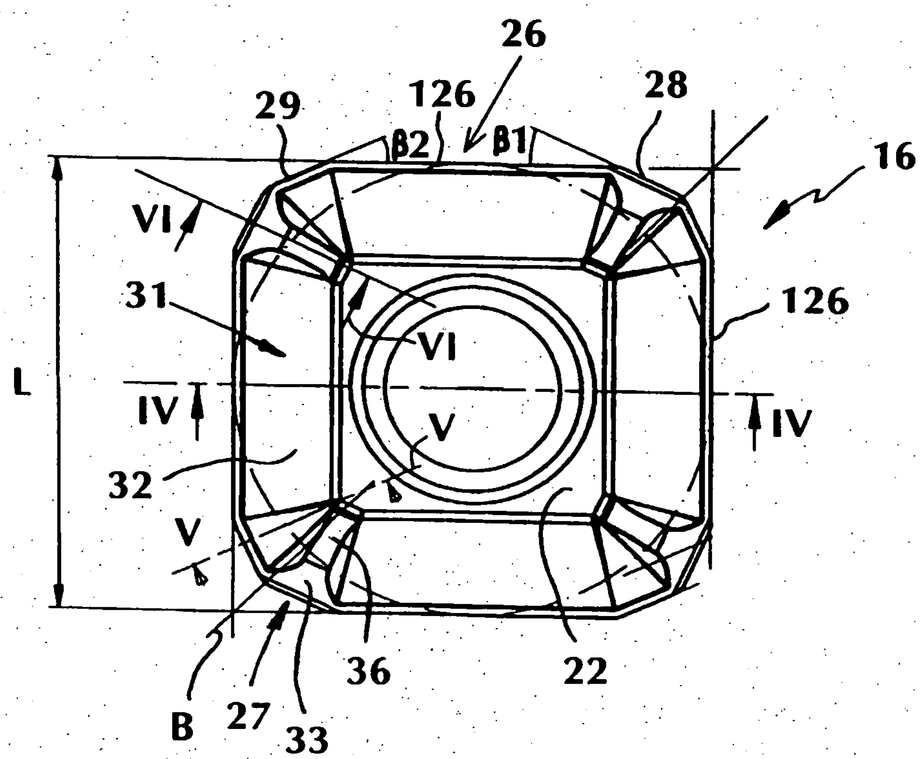
26
126
29
28
β2
β1
16
VI
31
VI
126
L
IV
IV
V
32
V
B
27
33
36
22

Fig. 3

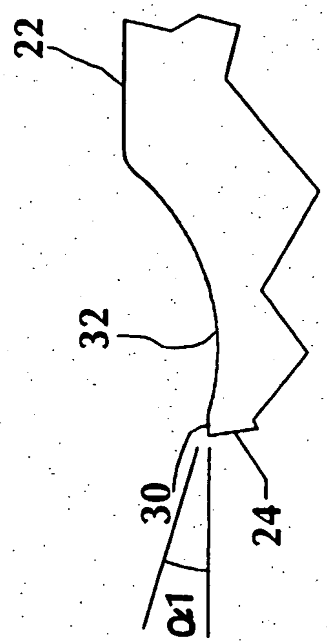

Fig. 5

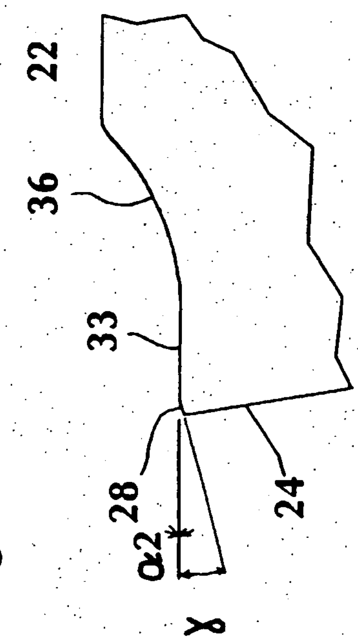

Fig. 6

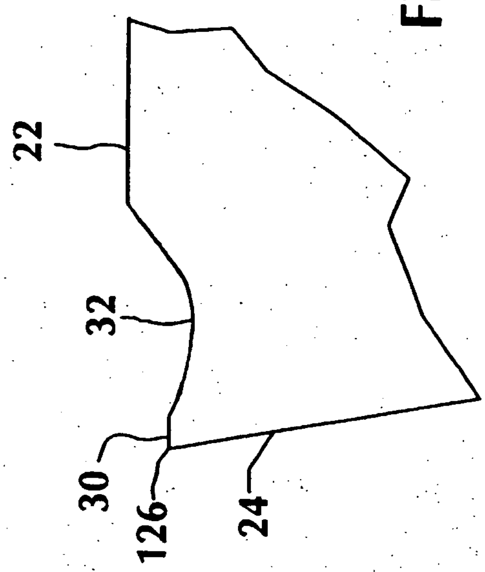

Fig. 10

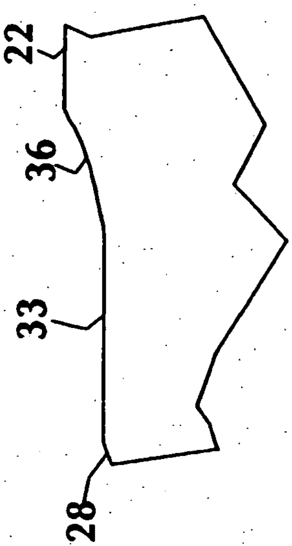

Fig. 9

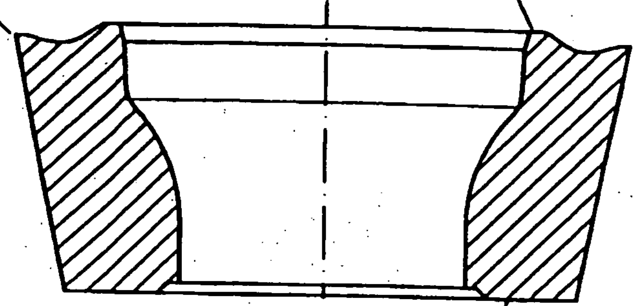

Fig. 8

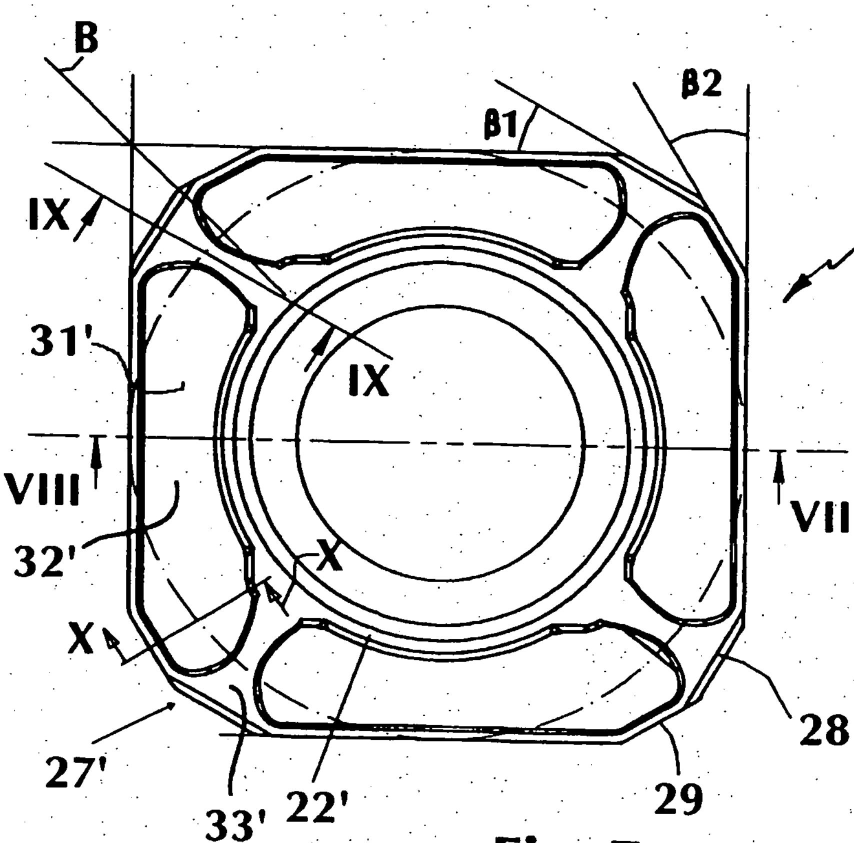

Fig. 7

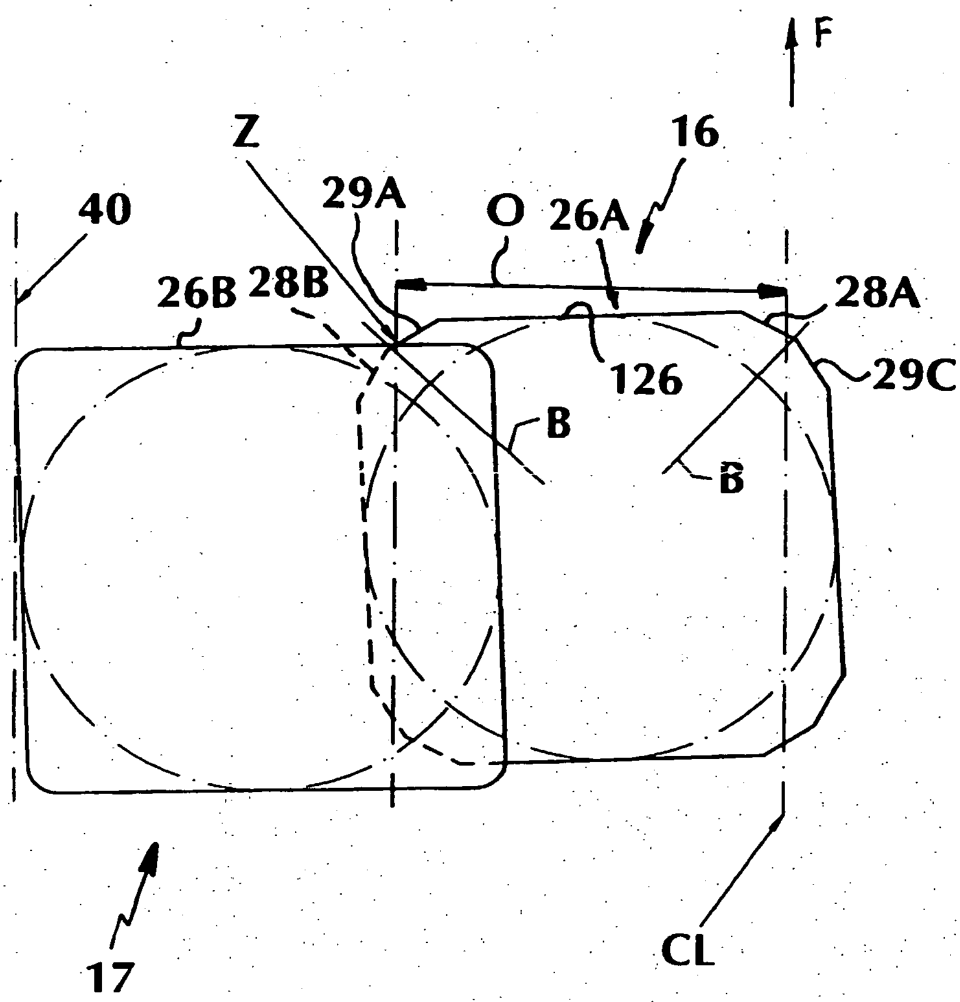

Fig. 11

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EUROPEAN SEARCH REPORT

Application Number
EP 98 85 0043

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	WO 94 16851 A (SANDVIK AB) 4 August 1994 * page 3, line 27 - page 4, line 16; figure 2 *	4	B23B51/00 B23B27/16
A	DE 38 42 209 A (WALTER GMBH MONTANWERKE) 21 June 1990 * figure 4 *	1	
A	US 4 342 368 A (DENMAN DENNIS) 3 August 1982 * abstract *	1,4	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B23B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	12 August 1998	Fischer, M

CATEGORY OF CITED DOCUMENTS

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